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# Preface

The computer based simulation of Fluid-Structure Interaction (FSI) problems has historical and practical importance in computational mechanics. FSI was one of the first systematically developed areas in the wider framework of what is now called computational multiphysics. Its development propelled original advances in modeling, solution algorithms and computer implementation of coupled models coming from two different disciplines: solid and fluid mechanics. Despite that relatively early start, the practical importance of computational FSI has remained undiminished. Among its important scientific and technological applications we can cite the following.

- Hydroelastic and sloshing vibrations in aerospace vehicles. Key problems are the prediction of Pogo effects in liquid propelled launchers, and the attitude control of satellites and spacecraft carrying fluid masses.
- Aero and hydroacoustics: the identification, isolation and control of airborne noise in aircraft, rockets and automobiles, as well as of sound radiation from submerged structures.
- Flow-induced motions: the study of flow-induced vibratory or transient motions in flexible or rigid bodies immersed in a gas or liquid (aircraft, bridges, high-rise buildings, sails, cables, ocean pipelines, rotating machinery, lubricated bearings), or of fluid-conveying devices such as reactor coolant pipes. Important subsets are aeroelasticity and aeroservoelasticity.
- Dynamic response of dams, reservoirs, pipes or vessels under seismic motions, attacks or accidents.
- Shock, vibration, and parametric resonance of marine structures such as ships, submarines and offshore platforms.
- Biomechanical problems in blood flow and clotting.
- Rapid phase change problems such as liquefaction or sublimation.
- Combustion machinery typified by engines, power plants, and disposal devices.
- Problems involving flow in porous, spongeous or fibrous media. Many of these occur in geomechanics and environmental engineering such as consolidation, sedimentation, dispersion, filtering, gas and oil recovery, and also in the development of sound-proofing materials for internal noise reduction problems.

This vast array of applications has one common feature. It brings forth not only the inherent complexities of modeling the fluid and structure as separate entities (for example, material and geometric nonlinearities and thermal effects), but the additional complication of their coupling and dynamic interaction.

This special volume of Computer Methods in Applied Mechanics and Engineering contains sixteen papers on the modeling and simulation of FSI problems. The first four papers are devoted to the linear analysis of internal fluid problems. These cover structural acoustics in the time and frequency domain, fluid-structure coupling methodologies, reduction of coupled dynamical models, and vibration and sloshing of incompressible liquids in elastic tanks with interface damping. The next three papers deal with the nonlinear analysis of internal fluid problems, treating large structural displacements, cold flow simulation, fluid-filled pipe vibrations, and rapid transients. The next two papers address computational aeroelasticity, studying computational methods for both frequency and transient response analysis. These are followed by three papers that focus on the interaction of fluids and rigid bodies, including rotating machinery, spatially periodic flows and the analysis of complex body-motion-induced flows. The following paper addresses flow in deformable porous media. The next one surveys partitioned analysis methods for coupled mechanical systems. The last paper describes recent developments in meshfree methods for discretizing contact-coupled problems.


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The editors are indebted to the authors for their contributions and cooperation, and thank the reviewers for their comments and suggestions. Collectively the papers cover a substantial subset of problems in the foregoing list. There remain, however, many open or barely broached problems that will present challenges to investigators; in particular the effective treatment of multiscale phenomena such as turbulence, cavitation, capillarity, fractal phase changes, and high fidelity interface modeling. It is hoped that the present selection will provide readers a panorama of the state of the art in computational FSI as well as an up-to-date guide to prior and ongoing research work.

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